# The development and application of strategic adaptive management within South African National Parks

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## Introduction

Adaptive management is an appealing approach to deal with inherent uncertainty in complex and interactive social-ecological systems (Holling 2001; Rogers 2003). In short, adaptive management is about learning-by-doing in a scientific way, adapting behaviour and overall direction as new information becomes available. It provides a structured way for improving our incomplete understanding through an iterative process of setting objectives, implementing policy decisions and evaluating the implications of their outcomes for future decision making. In essence, adaptive management is:

> the process of treating natural resource management as an experiment such that the practicality of trial and error is added to the rigour and explicitness of the scientific experiment, producing learning that is both relevant and valid.
>
> (Meffe *et al.* 2002)

When adaptive management is practiced, policies become hypotheses and management actions become the experiments to test those hypotheses (Folke *et al.* 2005).

First referred to as adaptive environmental assessment and management (AEAM) (Holling 1978; Walters 1986), adaptive management has grown into an established field of research and practice (Allan & Stankey 2009; Armitage, Berkes & Doubleday 2008; Meffe *et al.* 2002; Oglethorpe 2002; Walters 2002). Whilst there is a rich literature on the philosophical merits of adaptive management, the actual day-to-day implementation had faced many obstacles (Berkes, Colding & Folke 2003; Johnson 1999; Lee 1993; McLain & Lee 1996; Rogers 2003; Shea *et al.* 2002; Walters 1997). Yet a version of adaptive management that developed in South Africa has grown to become an integral part of the thinking, planning and decision-making within South African National Parks (SANParks). This version is referred to as strategic adaptive management (SAM) and this special issue is dedicated to reflecting on the development and implementation of SAM within SANParks and its stakeholder community over a 10-year period.

In this editorial we present a brief introduction to the main components and vocabulary of SAM as practiced by SANParks, as well as a roadmap through the papers that constitute the two parts of the special issue. The papers that follow in this special issue, and the references therein, will provide the reader with a rich source of literature and in-depth treatise of SAM and its development within SANParks.

## Strategic adaptive management in SANParks

### Philosophical foundation

The century-long evolution of management practices in the Kruger National Park is chronicled in Venter *et al.* (2008). An optimisation approach in the early years (c.1902–1980), as well as command-and-control (1955–1985) and *laissez-faire* (1985–1995) approaches were embraced before the adoption of adaptive management in 1995. The appropriateness of adaptive management for natural resource management in general, and its adoption by Kruger National Park, stems from a growing awareness of two critical challenges, (1) the existence of ecological complexity and social complexity and hence social-ecological complexity and (2) the existence of multiple stakeholders with diverse (and often divergent) perceptions, values and expectations.

A defining characteristic of complex systems is that patterns emerge or self-organise from the local interactions between components of the system. The interactions and feedbacks between components can be 'nonlinear', resulting in an inherent degree of unpredictability in cause-and-effect relationships and making them 'knowable' only in retrospect. An emergent property, for example patterns in organism distribution, is not a property of any single agent but of the system as a whole (Levin 1998, 1999; Snowden & Stanbridge 2004).

The second challenge relates to the multistakeholder nature of common-property natural resources; even fenced-off protected areas are increasingly influenced by external social issues

(Venter *et al.* 2008). These stakeholders may subscribe to widely varying world views, based on different values and knowledge forms, with expectations that play out over different time horizons and spatial scales. Under these circumstances, management should probably avoid targeting an optimal solution for 'the (single) problem', but should adopt an ongoing learning and negotiation process where mutual sense-making and adaptation are prioritised (Pahl-Wostl & Hare 2004). This reality has lead some authors and practitioners to coin the term 'adaptive co-management', as a descriptor of adaptive management that explicitly caters for mutual learning and cooperation between stakeholders such as conservation agencies, researchers and local communities (Armitage *et al.* 2007; Borrini-Feyerabend *et al.* 2000; Olsson, Folke & Berkes 2004; Ruitenbeek & Cartier 2001).

The presence of limited predictability (or a certain level of irreducible uncertainty), as well as multiple stakeholders with frequent conflicting interests, suggests that there are two fundamental conditions necessary for effective management of natural resources, (1) to learn and adapt and (2) to do so purposefully with relevant partners. SAM, which was initially developed in the context of managing rivers and their catchment areas (Biggs & Rogers 2003; Rogers & Bestbier 1997; Rogers & Biggs 1999), provides a framework for facilitating such learning. It incorporates the iterative learning dimension of adaptive management and the mutual learning dimension of co-management. In addition, it emphasises a forward-looking dimension, hence the reference to 'strategic'. In summary, as Grant *et al.* (2008) point out, SAM is designed to be strategic (facilitate action with foresight and purpose), adaptive (facilitate learning whilst we are doing) and participatory (facilitate engagement and empowerment of stakeholders).

SAM is a modular process that allows practitioners to start with any of the five broad steps in the adaptive cycle and to expand their efforts from there. The five steps can be grouped into three interrelated subprocesses or components that have taken shape in the application of SAM, namely adaptive planning, adaptive implementation and adaptive evaluation (Figure 1). In the following sections we introduce the basic steps of SAM in more detail.

## Adaptive planning

The adaptive planning process of SAM is seen increasingly as a critical condition for achieving its successful implementation (Rogers pers. comm., 14 September 2010). The aim of this process is to build a sense of common purpose amongst all relevant stakeholders and to develop a collective roadmap for getting from a current (usually undesirable) reality to a more desirable social-ecological system. Stakeholder inclusivity is vital to the success of an adaptive planning process. In the case of SANParks, stakeholders include park managers, scientists, government policymakers, agency managers, wildlife activists, traditional communities neighbouring parks, farmers that share catchments of rivers that flow through parks, NGOs and ecotourists. Successful adaptive planning depends on the facilitation of a constructive

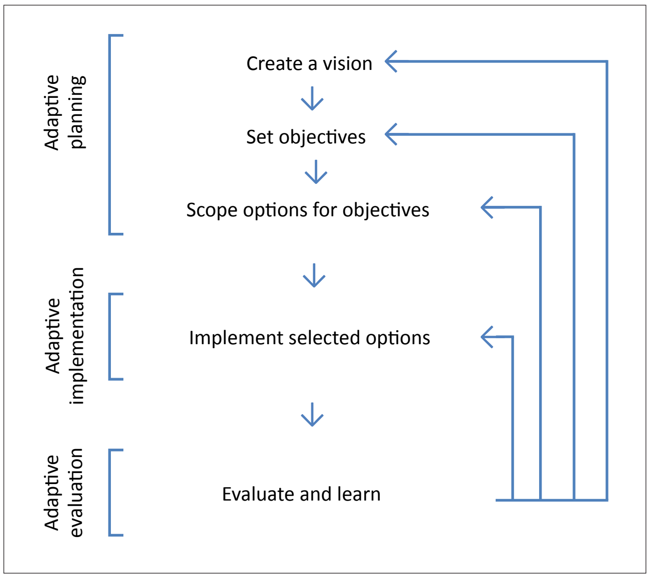


**FIGURE 1:** Schematic summary of the steps in the strategic adaptive management process, based on the work of Biggs, H.C. & Rogers, K.H., 2003, 'An adaptive system to link science, monitoring and management in practice', in J.T. du Toit, K.H. Rogers & H.C. Biggs (eds.), *The Kruger experience. Ecology and management of savanna heterogeneity*, pp. 59–80, Island Press, Washington DC; Pollard, S.R. & Du Toit, D.R., 2007, Guidelines for strategic adaptive management – Experiences from managing the rivers of the Kruger National Park. Guidelines of UNEP/GEF Project No. GF/27-13-03-4679. Ecosystems, Protected Areas and People Project; and Scholes, R.J. & Mennell, K.G., 2008, 'Summary for policymakers', in R.J. Scholes & K.G. Mennell (eds.), *Elephant management: A scientific assessment for South Africa*, pp. 1–21, Wits University Press, Johannesburg.

dialogue amongst these stakeholders with their diverse and often divergent values, expectations, professional norms and reward systems (Rogers & Breen 2003).

The first step in adaptive planning is to create a common vision in which stakeholders agree on the social, technical, economic, ecological and political contexts of the system to be managed. A critical part of this visioning exercise is to reach agreement on values, or operating principles, which should guide management decision making in the future. The V-STEEP (values, social, technical, economic, ecological and political) framework that emerges provides an approach to describing the context as comprehensively as possible (see Pollard & Du Toit 2007). A further part of visioning is to deliberate and reach consensus on the vital attributes of the system to be managed and their determinants. Vital attributes, as perceived by stakeholders, are the distinctive and special features of the social-ecological system of concern that are the key to its management (Rogers & Bestbier 1997).

A vision statement is formulated on the basis of this understanding of the context and values. The vision, together with the vital attributes of the system to be managed, informs the setting of objectives. A nested hierarchy of objectives starts with high-level objectives that are set, firstly, to ensure the maintenance of the identified vital attributes of the system to be managed and, secondly, to overcome the constraints and threats to meeting the vision. Through a step-by-step process, these high-level objectives (which are largely based on stakeholder values) are deconstructed into a series of objectives of increasing detail until they represent measurable, scientifically credible endpoints. The result is referred to as an objectives hierarchy (Figure 2).

Acknowledging the dynamic nature of ecosystems, the measurable targets (Figure 2) describe the boundaries of the desired state (as opposed to an optimal value). These boundaries are also referred to as thresholds of potential concern (TPCs) and are essentially hypotheses of the outer limits of acceptable change. These 'boundaries' are acceptable changes in the attribute of interest, embedded within specific temporal and spatial scales (see Foxcroft & McGeoch 2011). As such, their validity and appropriateness remains open to challenge and TPCs are revised as understanding of the system improves (Pollard & Du Toit 2007). TPCs are developed in collaboration between managers, scientists and field staff responsible for monitoring.

The last step that forms part of the adaptive planning process is to scope or analyse various options for achieving the objectives that were derived in the previous step. Importantly, this step is still conducted in cooperation with stakeholders. Different options are identified, their likely consequences predicted and the acceptability of those consequences assessed. Finally, a combination of management options that provide the best potential social-ecological system outcomes and learning opportunities is selected for implementation (Grant *et al.* 2008; Pollard & Du Toit 2007).

## Adaptive implementation

Adaptive implementation entails incorporating the options that were selected in the previous step as part of the operating procedures and business routines of the relevant organisation(s). This requires the development of detailed action plans, allocation of the necessary resources and the implementation of those plans. A key component of the adaptive implementation of action plans is to develop monitoring protocols to describe the subject and focus of what to monitor and establish the frequency at which to do so. Monitoring endpoints are linked to the measurable targets (or TPCs) in Figure 2.

Part of the 'new' management procedures is to establish a forum for the regular evaluation of monitoring results against set TPCs, as well as standard procedures for dealing with TPC excedance and for capturing and sharing learning (Pollard & Du Toit 2007).

## Adaptive evaluation

One of the main purposes of SAM (and adaptive management in general) is to purposefully learn and adapt over time. Therefore, it is essential that learning becomes an explicit step in the strategic adaptive management process (Figure 1). However, learning should not be seen as a mere step to be taken at the end of the process, but should rather occur throughout the planning and implementation phases via a series of feedback loops. Continuous evaluation and learning is facilitated by reflecting on the following questions (Figure 3):

- Is the monitoring adequate, cost effective and feasible?
- Has the intended plan of operation materialised?
- Were the selected options appropriate?
- Were the predicted consequences correct and, if not, why?
- Were the consequences actually acceptable?
- Even if the predicted consequences were correct and are acceptable, are the objectives and vision being met?

# Roadmap through this special issue

The papers contained in this special issue were solicited to capture and share as much as possible of the experience gained by SANParks during the development and implementation of SAM to date. The authors were allowed a fair degree of freedom to ensure that a broad spectrum of perspectives and diverse lessons are captured in the special issue. We refer to the papers in this issue as essays rather than research papers as some of the authors use a narrative writing style to convey their understanding of SAM.

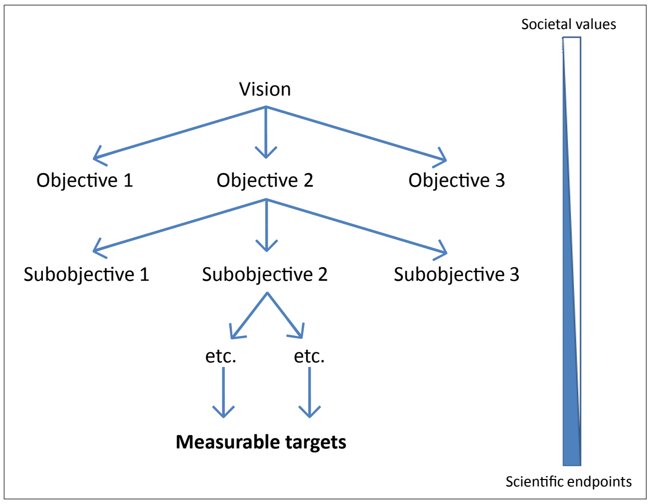


**FIGURE 2:** Generic objectives hierarchy that links the vision to scientific endpoints, based on the work of Pollard, S.R. & Du Toit, D.R., 2007, Guidelines for strategic adaptive management – Experiences from managing the rivers of the Kruger National Park. Guidelines of UNEP/GEF Project No. GF/27-13-03-4679. Ecosystems, Protected Areas and People Project; Rogers, K. & Bestbier, R., 1997, *Development of a protocol for the definition of the desired state of riverine systems in South Africa,* Department of Environmental Affairs and Tourism, Pretoria; and Rogers, K.H. & Biggs, H.C., 1999, 'Integrating indicators, endpoints and value systems in strategic management of the Kruger National Park', *Freshwater Biology* 41, 439–451. doi:10.1046/j.1365-2427.1999.00441.x.

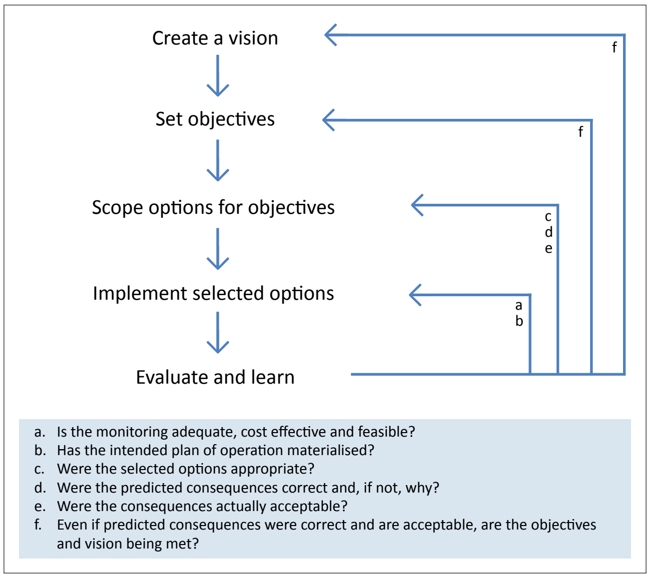


**FIGURE 3:** The adaptive management process with feedback loops for ongoing reflective learning at multiple points during the process.

The papers in the special issue can be divided into two parts. Part one consists of papers of a more systemic, generic or philosophical nature, whilst the papers in part two focus largely on thresholds of potential concern and how these thresholds were derived and applied for specific target indicators. Whilst each paper can be read on its own, the papers from part one and part two are meant to be complementary.

Part one starts off with a detailed contextual setting of the Kruger National Park as the main study area for the development of SAM (Pollard *et al.* 2011). The authors of this essay provide an historical overview of how changes in management paradigms eventually led to the adoption of SAM as the approach of choice, as well as how this approach was pioneered in the sphere of river management. In the next essay, Biggs, Breen, Slotow, Freitag-Ronaldson and Hockings (2011) examine the relationship between assessment and reflection, focusing on how these processes can be used in a complementary way to catalyse learning for adaptive management. Stirzaker *et al.* (2011) allude to the often contradicting nature of the entrained behaviour of many scientists and managers alike, as well as the behaviour required to participate effectively in an adaptive management process. They explore the shortcomings and requirements of organisations in terms of enabling adaptive management. In the fourth essay, Holness and Biggs (2011) address a question that is of critical importance to a conservation agency: are systematic conservation planning and adaptive management compatible processes? These authors argue that systematic conservation planning should be practiced as an intrinsic part of a broader adaptive management approach and suggest how such a marriage can be achieved. Systematic monitoring is a key factor in our ability to learn and adapt. To this end, McGeoch *et al.* (2011) propose a framework for biodiversity monitoring which would address the biodiversity objectives as outlined in the management plans of South African National Parks. Gaylard and Ferreira (2011) reflect on how the process of SAM itself has been adapted in response to various implementation challenges. The final essay in part one of this issue provides a transition to the part two papers. Biggs, Ferreira, Freitag-Ronaldson and Grant-Biggs (2011) provide a critical assessment of the usefulness of the concept of thresholds of potential concern. These authors propose a reconceptualisation of the TPC concept, based on learning over a period of one decade, to increase its utility within the SAM process.

Part two contains a collection of 11 essays, each focusing on a specific theme. These essays aim to summarise the development of TPCs for the particular theme and assess how this fits into the broader strategic adaptive management approach. These areas have not received the same amount of attention over the last decade. Therefore, whilst some papers will provide an in-depth discussion of their evolution, others will present recent developments and provide suggestions for future directions. As the pioneering work on SAM in the Kruger National Park was conducted on river management, McLoughlin *et al.* (2011) take us through a journey explaining the history and rationale behind the TPC concept. Furthermore, they show how the TPCs for river management were used and how they evolved as learning progressed. Fire research and management in SANParks has been an ongoing process for a number of decades, with a number of different approaches being implemented, both within and across parks nationwide. Van Wilgen *et al.* (2011) discuss the changes from 'trial and error' through to 'active adaptive management', indicating the development of various forms of thresholds. Another area where adaptive management approaches and TPCs have developed over a number of years is with invasive alien species. Here Foxcroft and McGeoch (2011) aim to link the management actions, monitoring programme, research efforts and TPCs in order to develop functional feedback mechanisms and enable improved management and learning.

Whilst not discussing the development of TPCs specifically, a number of essays propose approaches to adopting an adaptive management strategy. They also suggest TPCs and aim to test the use of these in particular cases. For example, Grant *et al.* (2011) evaluate herbivore–vegetation interactions and how determining thresholds for these can prevent unacceptable changes in desired vegetation states and patterns. McGeoch *et al.* (2011) deal with approaches to monitoring the often neglected terrestrial and freshwater biodiversity. Similarly, except for some specific case studies, resource use management has been given little attention until recently. In their essay, Scheepers *et al.* (2011) provide an overall framework for applying adaptive approaches to resource use management. They illustrate this with three case studies, covering a range of approaches and timeframes, and conclude with opportunities for future expansion. As global environmental change intensifies, one of the most pressing issues that conservation and protected area managers face is ensuring the persistence of rare species (Rebelo *et al.* 2011). However, in areas with high endemicity, and which are facing a number of potentially negative impacts, assessing which species are most in need of special attention is problematic. For example, Table Mountain National Park has 307 threatened IUCN Red List (plus 208 non-least concern) and 332 endemic terrestrial plant and animal species. Rebelo *et al.* (2011) present an approach to dealing with this challenging problem.Four essays probe some underlying philosophical or technical issues, including the idea that behind all good science lies good science support. This is an essential but underrated part of the overall science management and monitoring partnership. Kruger and MacFadyen (2011) discuss a number of innovations that deal with these issues, from collecting, managing and automating data management, to developing systems to report back on TPCs. A challenge with implementing TPCs is determining at what stage the breach of a TPC is triggered and how the lag effects of this breach are handled. Scholes and Kruger (2011) present a potential approach to this, illustrating it with an example from the Kruger National Park. Owing to the different needs and analytical approaches necessary to implementing TPCs and management across the SANParks estate, Ferreira *et al.* (2011) use conceptual linkages between objectives, indicators, mechanisms and modulators to help identify key concerns in relation to management objectives. Based on these linkages, the underlying mechanisms responsible for the management concern may be evaluated.

## Conclusion

The dominant message that emerges from the papers in this special issue is that adaptive management is about structured learning. The authors reflect on various mechanisms that are used to make current assumptions and understanding explicit so that relevant stakeholders can learn in a structured way. These mechanisms include co-creating a desired state or vision, setting objectives, formulating thresholds of potential concern, and monitoring and evaluating the consequences of management decisions. This volume of papers represents a comprehensive documentation and reflection of this process, after applying the principles of SAM across an entire conservation agency for over 10 years.

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